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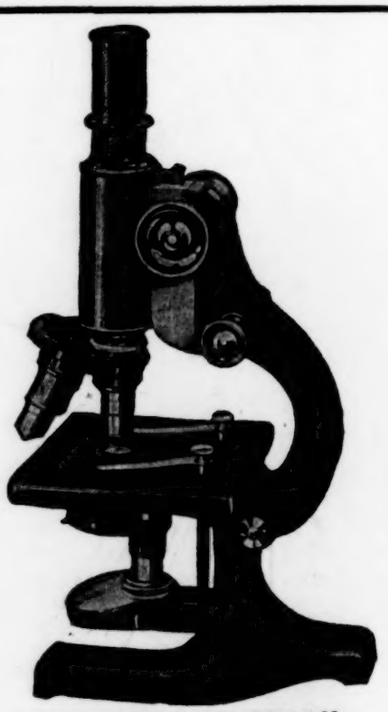

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## ENGINEERING SCIENCE BEFORE, DURING AND AFTER THE WAR[1]

THREE years of anxiety and stress have passed since the last meeting of the British Association. The weight of the struggle which pressed heavily upon us at the time of the Newcastle meeting in 1916 had increased so much in intensity by the spring of 1917 that the council, after consultation with the local committee at Bournemouth, finally decided to cancel the summer meeting of that year. This was the first time in the history of the association that an annual meeting was not held.

We all rejoice to feel that the terrible ordeal through which the whole empire has been passing has now reached its final phases, and that during the period of reorganization, social and industrial, it is possible to resume the annual meetings of the association under happier conditions. We have gladly and with much appreciation accepted the renewed invitation of our friends and colleagues at Bournemouth.

We are gathered together at a time when, after a great upheaval, the elemental conditions of organization of the world are still in flux, and we have to consider how to influence and mould the recrystallization of these elements into the best forms and most economic rearrangements for the benefit of civilization. That the British Association is capable of exerting a great influence in guiding the nation towards advancement in the sciences and arts in the most general sense there can be no ques-

[1] Address of the president of the British Association for the Advancement of Science, Bournemouth, 1919.

tion, and of this we may be assured by a study of its proceedings in conjunction with the history of contemporary progress. Although the British Association can not claim any paramount prerogative in this good work, yet it can certainly claim to provide a free arena for discussion where in the past new theories in science, new propositions for beneficial change, new suggestions for casting aside fetters to the advancement in science, art, and economics have first seen the light of publication and discussion.

For more than half a century it has pleaded strongly for the advancement of science and its application to the arts. In the yearly volume for 1855 will be found a report in which it is stated that:

> The objects for which the association was established have been carried out in three ways: First, by requisitioning and printing reports on the present state of different branches of science; secondly, by granting sums of money to small committees or individuals, to enable them to carry on new researches; and thirdly, by recommending the government to undertake expeditions of discovery, or to make grants of money for certain and national purposes, which were beyond the means of the association.

As a matter of fact it has, since its commencement, paid out of its own funds upwards of £80,000 in grants of this kind.

## DEVELOPMENTS PRIOR TO THE WAR

It is twenty-nine years since an engineer, Sir Frederick Bramwell, occupied this chair and discoursed so charmingly on the great importance of the next-to-nothing, the importance of looking after little things which, in engineering, as in other walks of life, are often too lightly considered.

The advances in engineering during the last twenty years are too many and complex to allow of their description, however short, being included in one address, and, following the example of some of my predecessors in this chair, I shall refer only to some of the most important features of this wide subject. I feel that I can not do better than begin by quoting from a speech made recently by Lord Inchcape, when speaking on the question of the nationalization of coal: "It is no exaggeration to say that coal has been the maker of modern Britain, and that those who discovered and developed the methods of working it have done more to determine the bent of British activities and the form of British society than all the Parliaments of the past hundred and twenty years."

*James Watt.*—No excuse is necessary for entering upon this theme, because this year marks the hundredth anniversary of the death of James Watt, and in reviewing the past it appears that England has gained her present proud position by her early enterprise and by the success of the Watt steam-engine which enabled her to become the first country to develop her resources in coal, and led to the establishment of her great manufactures and her immense mercantile marine.

The laws of steam which James Watt discovered are simply these: That the latent heat is nearly constant for different pressures within the ranges used in steam-engines, and that, consequently, the greater the steam pressure and the greater the range of expansion, the greater will be the work obtained from a given amount of steam. Secondly, as may now seem to us obvious, that steam from its expansive force will rush into a vacuum. Having regard to the state of knowledge at the time, his conclusions appear to have been the result of close and patient reasoning by a mind endowed with extraordinary powers of insight into physical questions, and with the faculty of drawing sound practical conclusions from numerous experiments de-

vised to throw light on the subject under investigation. His resource, courage and devotion were extraordinary.

In commencing his investigations on the steam-engine he soon discovered that there was a tremendous loss in the Newcomen engine, which he thought might be remedied. This was the loss caused by condensation of the steam on the cold metal walls of the cylinder. He first commenced by lining the walls with wood, a material of low thermal conductivity. Though this improved matters, he was not satisfied; his intuition probably told him that there should be some better solution of the problem, and doubtless he made many experiments before he realized that the true solution lay in a condenser separate from the cylinder of the engine. It is easy after discovery to say, "How obvious and how simple," but many of us here know how difficult is any step of advance when shrouded by unknown surroundings, and we can well appreciate the courage and the amount of investigation necessary before James Watt thought himself justified in trying the separate condenser. But to us now, and to the youngest student who knows the laws of steam as formulated by Carnot, Joule and Kelvin, the separate condenser is the obvious means of constructing an economical condensing engine.

Watts experiments led him to a clear view of the great importance of securing as much expansion as possible in his engines. The materials and appliances for boiler and machine construction were at that time so undeveloped that steam pressures were practically limited to a few pounds above atmospheric pressure. The cylinders and pistons of his engines were not constructed with the facility and accuracy to which we are now accustomed, and chiefly for these reasons expansion ratios of from twofold to threefold were the usual practise. Watt had given to the world an engine which consumed from five to seven pounds of coal per horse-power hour, or one-quarter of the fuel previously used by any engine. With this consumption of fuel its field under the conditions prevailing at the time was practically unlimited. What need was there, therefore, for commercial reasons, to endeavor still further to improve the engine at the risk of encountering fresh difficulties and greater commercial embarrassments? The course was rather for him and his partners to devote all their energy to extend the adoption of the engine as it stood, and this they did, and to the Watt engine, consuming from five to seven pounds of coal per horse-power, mankind owes the greatest permanent advances in material welfare recorded in history.

With secondary modifications, it was the prime mover in most general use for eighty years, *i. e.* until the middle of last century. It remained for others to carry the expansion of steam still further in the compound, triple, and, lastly, in the quadruple expansion engine, which is the most economical reciprocating engine of to-day.

Watt had considered the practicability of the turbine. He writes to his partner, Boulton, in 1784: "The whole success of the machine depends on the possibility of prodigious velocities. In short, without God makes it possible for things to move them one thousand feet per second, it can not do us much harm." The advance in tools of precision, and a clearer knowledge of the dynamics of rotating bodies, have now made the speeds mentioned by Watt feasible, and, indeed, common, everyday practise.

*Turbines.* The turbine of to-day carries the expansion of steam much further than has been found possible in any reciprocating engine, and owing to this property it

has surpassed it in the economy of coal, and it realizes to the fullest extent Watt's ideal of the expansion of steam from the boiler to the lowest vapor pressure obtainable in the condenser.

Among the minor improvements which in recent years have conduced to a higher efficiency in turbines are the more accurate curvature of the blades to avoid eddy losses in the steam, the raising of the peripheral velocities of the blades to nearly the velocity of the steam impinging upon them, and details of construction to reduce leakages to a minimum. In turbines of 20,000–30,000 h. p., 82 per cent. of the available energy in the steam is now obtainable as break-horse-power; and with a boiler efficiency of 85 per cent. the thermodynamic efficiency from the fuel to the electrical output of the alternator has reached 23 per cent., and shortly may reach 28 per cent., a result rivalling the efficiency of internal-combustion engines worked by producer-gas.

During the twenty years immediately preceding the war turbo-generators had increased in size from 500 kilowatts to 25,000 kilowatts, and the consumption of steam had fallen from 17 pound per kw.-hour to 10.3 pound per kw.-hour. Turbines have become the recognized means of generating electricity from steam on a large scale, although they have not superseded the Watt engine for pumping mines or the drawing of coal, except in so far as it is a means for generating electricity for these purposes. In the same period the engine-power in the mercantile marine had risen from 3,900 of the *King Edward* to 75,000 of the *Mauretania.*

As regards the Royal Navy, the engine-power of battleships prior to the war had increased from 12,000 i.h.p., to 30,000 s.h.p., while the speed advanced from 17 knots to 23 knots, and during the war, in ships of the *Queen Elizabeth* class, the power amounted to 75,000 s.h.p., with a speed of 25 knots. In cruisers similar advances were made. The i.h.p. of the *Powerful* was 25,000, while the s.h.p. of the *Queen Mary* was 78,000, with a speed of 28 knots. During the war the power obtained with geared turbines in the *Courageous* class was 100,000 s.h.p., with a speed of 32 knots, the maximum power transmitted through one gear-wheel being 25,000 h.p., and through one pinion 15,500 h.p.; while in destroyers speeds up to 39 knots have been obtained. The aggregate horse-power of war and mercantile turbined vessels throughout the world is now about 35,000,000.

These advances in power and speed have been made possible mainly by the successive increase in economy and diminution of weight derived from the replacement of reciprocating engines by turbines direct-coupled to the propellers, and later by the introduction of reduction gearing between the turbines and the propellers; also by the adoption of water-tube boilers and of oil-fuel. With these advances the names of Lord Fisher, Sir William White, and Sir Henry Oram will always be associated.

*The Work of Sir William White.*—With the great work of the Royal Navy fresh in our minds, we can not but recall the prominent part taken by the late Sir William White in its construction. His sudden death, when president-elect for 1913, lost to the nation and to the association the services of a great naval architect who possessed remarkable powers of prevision and dialectic. He was Chief Constructor to the Admiralty from 1885 to 1901, and largely to him was due the efficiency of our vessels in the great war.

White often referred to the work of Brunel as the designer of the *Great Eastern,* and spoke of him as the originator of the cellular construction of the bottoms of ships, since universally adopted, as a means of strengthening the hull and for ob-

taining additional safety in case of damage. Scott Russell was the builder of this great pioneer vessel, the forerunner of the Atlantic liners, and the British Association may rightly feel satisfaction in having aided him when a young man by pecuniary grants to develop his researches into the design and construction of ships and the wave-line form of hull which he originated, a form of special importance in paddle-wheel vessels.

So much discussion has taken place in the last four years as to the best construction of ship to resist torpedo attacks that it is interesting to recall briefly at the present time what was said by White in his Cantor lectures to the Royal Society of Arts in 1906:

> Great attention has been bestowed upon means of defence against underwater torpedo attacks. From the first introduction of torpedoes it was recognized that extreme watertight subdivision in the interior of warships would be the most important means of defence. Experiments have been made with triple watertight skins forming double cellular sides, the compartments nearest the outer bottom being filled, in some cases, with water, coal, cellulose, or other materials. Armor-plating has been used both on the outer bottom and on inner skins.

He also alludes to several Russian ships which were torpedoed by the Japanese, and he concludes by saying:

> "Up to date the balance of opinion has favored minute watertight subdivisions and comparatively thin water-tight compartments, rather than the use of internal armor, the use of which, of course, involves large expenditure of weight and cost."

The present war has most amply confirmed his views and conclusions, then so lucidly and concisely expressed.

While on the subject of steamships, it may perhaps be opportune to say one word as to their further development. The size of ships had been steadily increasing up to the time of the war, resulting in a reduction of power required to propel them per ton of displacement. On the other hand, thanks to their greater size and more economical machinery, speeds have been increased when the traffic has justified the greater cost. The limiting factor to further increase in size is the depth of water in the harbors. With this restriction removed there is no obstacle to building ships up to 1,000 feet in length or more, provided the volume and character of the traffic are such as to justify the capital outlay.

*Tungsten Steel.*—Among other important pre-war developments that have had a direct bearing upon the war, mention should be made of the discovery and extensive use of alloys of steel. The wonderful properties conferred upon steel by the addition of tungsten were discovered by Muschet in 1868, who has not been sufficiently credited with his share in making the Bessemer process a practical success, and later this alloy was investigated and improved by Maunsel White and Taylor, of Philadelphia. The later showed that the addition of tungsten to steel has the following effect: That after the steel has been quenched at a very high temperature near its melting point, it can be raised to a much higher temperature than is possible with ordinary carbon tool-steel without losing its hardness and power of cutting metal. In other words, it holds the carbon more tenaciously in the hardened state, and hence tungsten-steel tools, even when red-hot, can cut ordinary mild steel. It has revolutionized the design of machine tools, and has increased the output on heavy munition work by 100 per cent., and in ordinary engineering by 50 per cent.

The alloys of steel and manganese with which Sir Robert Hadfield's name is associated have proved of utility in immensely increasing the durability of railway and tramway points and crossings, and for the hard teeth of machinery for the crushing of stone and other materials, and, in fact, for

any purposes where great hardness and strength are essential.

*Investigation of Gaseous Explosions.*—Brief reference must also be made—and it will be gratifying to do so—to the important work of one of the committees of the British Association appointed in 1908, under the chairmanship of the late Sir William Preece, for the investigation of gaseous explosions, with special reference to temperature. The investigations of the committee are contained in seven yearly reports up to 1914. Of the very important work of the committee I wish to refer to one investigation in particular, which has proved to be a guiding star to the designers and manufacturers of internal-combustion engines in this country. The members of the committee more directly associated with this particular investigation were Sir Dugald Clerk, Professor Callendar, and the late Professor Bertram Hopkinson.

The investigation showed that the intensity of the heat radiated by the incandescent gases to the walls of the cylinder of a gas-engine increases with the size of the cylinder, the actual rate of this increase being approximately proportional to the square root of the depth of the radiating incandescent gas; the intensity was also shown to increase rapidly with the richness of the gas. It suffices now to say that the heat in a large cylinder with a rich explosive mixture is so intense that the metal eventually cracks. The investigation shows why this occurs, and by doing so has saved enormous sums to the makers of gas- and oil-engines in this country, and has led them to avoid the large cylinder, so common in Germany before the war, in favor of a multiplicity of smaller cylinders.

Charles A. Parsons

*(To be continued)*

## A QUESTION CONCERNING THE NATURE OF VELOCITY

Tolman's remarkable success in deriving by means of his principle of similitude[1] a large number of physical laws, laws which have also been otherwise derived by the more natural and usual method of experimentation and measurement, ought to indicate that there is probably something fundamentally right about his method of procedure. His argument involves two universes, while physics knows only one—and the bearing of his conclusions upon the single universe that we know is not altogether apparent. When he further asks it to be assumed that the velocity of light and the charge of the electron shall be the same in both universes, his argument seems far removed from the facts of the laboratory and its relevance to the usual physics may be, and indeed has been, brought into serious question.

But his argument may be developed without any appeal to two universes. So developed it has an important bearing upon the theories of the nature of electricity and of the manner of the propagation of light. Consider any two observers in our present universe, each of whom with a different set of standards of measurement makes experiments and determines laws. The laws determined by the two observers will have the same algebraic form and will differ only in the value of the constants which they involve. Since all of the measureable quantities of physics are defined in terms of three fundamental and ultimately undefined quantities, each observer will need only three standards[2] in order that he may

[1] Tolman, *Phys. Rev.*, 3, 244, 1914; 4, 145, 1914; 6, 219, 1915; 8, 8, 1916; 9, 237, 1917. Buckingham, *ibid.*, 4, 345, 1914. Nordstrom, *Finska Vetenskaps Soc. Forh.*, 57, 1914–15; Afd. A. No. 22. Ishiwara, *Science Report of Tohoku Imp. Univ.*, 5, 33, 1916. Ehrenfest-Afanassjewa, *Phys. Rev.*, 8, 1, 1916. Bridgman, *ibid.*, 8, 423, 1916. Karrer, *ibid.*, 9, 290, 1917.

[2] All seem agreed that length and time are fundamental and undefinable. About the third quantity, force or mass, or energy, as the case may be, there seems to be considerable debate. The argument of the present paper is valid, whichever one of them is favored. I have chosen *force* be-

measure all quantities which come within his observation. The standards of the two observers, $O$ and $O'$, may be connected by algebraic equations, for length, $l' = x\,l$, for time $t' = yt$, and for force, $f' = zf$, where $x$, $y$ and $z$ are constants which may have any value and which express the ratio between the magnitudes of the corresponding standards of the two observers. From these three equations corresponding "transformation equations," involving $x$, $y$ and $z$, for all of the measureable quantities of physics may be calculated. Suppose now that the two observers got together and $O$ says to $O'$:

Surely it is the privilege of each of us to work with whatever standards he prefers, you prefer foot-seconds while I prefer gram-centimeters; yet let us, for such and such reasons and for our mutual convenience, each still keeping his standards different from those of the other, so alter our standards that we can both report all electrical charges and all velocities by precisely the same numerical value.

$O'$ may be conceived to reply:

We know indeed that electrical charges are made up of a number of ultimate charges or electrons and that each of these little charges has the same magnitude. If we report all charges by the same number, that is virtually the same as each of us reporting the same count. I see that in favor of your suggestion, but I know of no corresponding consideration in regard to velocity. I see that there is only one really correct way of reporting the magnitude of charges. But I do not see that such is the case for velocities.

Suppose however, that $O$ and $O'$ do put the agreement into effect. Then $v' = v$, and $e' = e$.

Then

$$v' = \frac{l'}{t'} = \frac{xl}{yt} = \frac{x}{y}(v) = v; \quad \text{and} \quad x = y.$$

Also

$$e' = \sqrt{f'l'^2} = \sqrt{zfx^2l^2} = x\sqrt{z}\cdot\sqrt{fl^2} = x\sqrt{z}\cdot e = e; \quad \text{and} \quad z = \frac{1}{x^2}.$$

Transformation equations involving only one unknown quantity, $x$, may now be written connecting all of the measurable quantities of $O$ with the corresponding quantities of $O'$. These equations are identical with those of Tolman; and $O$ and $O'$, working with the perfectly legitimate[3] mathematical reasoning that Tolman uses, may derive, by virtue of their simple agreement, all of the conclusions which he derives from his principle of similitude.

So long as $O$ and $O'$ have no agreement between themselves, the transformation equations connecting their various quantities will involve three unknown quantities, $x$ $y$ and $z$.

cause it seems to me to be primary in the course of experience, not because it makes any difference in the general argument. Many physicists, perhaps most, are disposed to believe that there are two additional fundamental and ultimately undefined quantities necessary to complete the structure of modern physics, namely, (1) temperature or entropy (for thermodynamics) and (2) quantity of electricity or magnetic permeability (for electromagnetics). But temperature is defined by the gas-law, and charge is defined by Coulomb's law. These laws, discovered by the experimentation of workers in whose minds temperatures and charges (respectively) were regarded as equal if in similar situations they produced equal effects, have gradually come in the history of science to assume the sacred functions reserved for definitions. It can not be asserted too strongly that they are *not* "*laws.*" This, however, is methodology, not theoretical physics, and not the central argument of the present paper.

[3] To illustrate the method of reasoning—The transformation equation for energy density is

$$u' = \frac{1}{x^4}u,$$

and that for temperature,

$$T' = \frac{1}{x}T.$$

If energy density is a function solely of temperature, then $u = F(T)$ and $u' = F(T')$ where $F$ in both equations has precisely the same value, for both observers obviously will find the same law. Substituting in the equation $u' = F(T')$, we have

$$\frac{1}{x^4}u = F\left(\frac{1}{x}T\right).$$

But $u = F(T)$, hence

$$\frac{1}{x^4}F(T) = F\left(\frac{1}{x}T\right).$$

The only solution of this functional equation is $F(a) = ka^4$. Hence $u = kT^4$, and Stefan's law has been demonstrated without experiment.

Only when the number of these unknown quantities is reduced to one, does it become possible for them to make use of the mathematical reasoning, involving the solution of functional equations, which has led in the hands of Tolman to such a wide variety of useful results. Since $x$ is the ratio between their standards of length-measurement, and $y$ that between their standards of time-measurement, they can express $y$ in terms of $x$ if they agree to make the same numerical report about any one kind of quantity which involves both length and time for its definition, that is, if they agree to make the same reports either about velocities or about accelerations. By making a corresponding second agreement about some quantity which involves for its definition force *and* time *or* length *or both*, such for instance as charge or mass or energy, they will be able to express $z$ in terms of $x$—and to derive an entire set of transformation equations which involve only one unknown quantity. With this new set of equations at hand, they may undertake to set up functional expressions and to derive laws as Tolman has done.

Evidently the number of the different possible sets of transformation equations is quite considerable, for there are many measurable quantities in physics which involve for their definition more than one of the three fundamental undefined quantities. I have calculated nine such different sets. Several of them lead to *some* of the conclusions which may be deduced from the equations of $O$ and $O'$ above (based upon agreements concerning velocities and charges); several of them lead, in cases where the set of $O$ and $O'$ has proved fertile, to insoluble or absurd functional equations which point to no solution. Some of them lead to laws which are contrary to those whose validity has been established by experiment. None of the sets is as fertile or leads to as many well established laws as the set which is based upon the agreement of $O$ and $O'$ to report all charges and all velocities by the same numerical value. But this agreement is the only thing in the way of an *assumption* which is involved in the simplified form of Tolman's principle of similitude that is developed by $O$ and $O'$ of this paper. The noteworthy success of Tolman in deriving from his principle a large number of experimentally valid laws is evidence that an agreement between observers working with different standards of measurement to report the same charges and velocities by the same number is somehow more intimately in harmony with the order of nature than any other similar agreement relative to some other of the quantities of physics.

Electrical charges may be regarded as if they are made up of a countable number of small units. This has been adequately demonstrated by the researches of Millikan and others in which electrons have actually been isolated and counted. But it could also have been predicted—for, as an assumption, it leads in the hands of $O$ and $O'$ to many conclusions which are otherwise verified by experimental fact. In the same way the assumption that velocities are of such sort that there is only one right way to report their magnitude, is one which leads, vastly better than any similar assumption, to the deduction of laws which are established in fact. Hence the assumption is probably true.

Professor Tolman has kindly read the first draft of this paper. He suggests that the conclusion that velocity is of such nature that there is only one right way to report its magnitude, a conclusion which has here been reached by abstract reasoning, may be interpreted concretely to mean that "any given velocity is most sensibly regarded as a given fraction of the maximum possible velocity, namely that of light."

Tenney L. Davis

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## JACQUES DANNE

With the outbreak of the world conflict in 1914 *Le Radium* at once ceased publication, all of its editors being called into service. The decision for service was no less definite than the assurance that publication would be

resumed with the coming of peace. Little did any one think that the renewal of publication would be in the hands of other than Jacques Danne. Indeed, the war being finally over Danne himself was busy with the preparation of the first new number when a sudden and rapid illness culminated in his death on March 8, leaving the science of radio-activity and electronics sadly weakened.

Jacques Danne was born in Paris in 1882. After excellent schooling he entered the Ecole de Physique et Chemie de Paris in 1897, where he distinguished himself as the first in a remarkable class of scientific students. He was invited by Curie to become his assistant in 1902, and at once added the power of his knowledge to Curie's work. Curie, working entirely as a physicist, had met innumerable problems which were leading up to the disintegration theory. The chaotic condition of the science of radioactivity in the years 1898–1902 was due chiefly to the fact that it was carried on by physicists without aid of chemical methods. These latter Soddy supplied in Montreal and Danne in Paris, and within a year the fact of atomic disintegration was established, and radio-activity became a science.

In 1904 M. Danne founded *Le Radium*, the first number of which appeared on July 15. He gathered about him an impressive "scientific committee" to insure an adequate treatment of all phases of the sciences of radioactivity and electronics, radiation and ionization; in short, of subatomic phenomena. For ten years he gave the greater part of his time to this journal, and in 1914 it was the sole representative of this very vital field of knowledge.

Six numbers of Volume 11 appeared in 1914, and now Number 7, Volume 11, appears in May, 1919, under the direction of Gaston Danne, the younger brother of Jacques, who for many years has been the chief spirit in the admirable Laboratoire d'Essais des Substances Radioactives, which Danne established at Gif in the Vallée de la Chevreuse.

The loss of Jacques Danne is irreparable, but under the direction of M. Gaston Danne *Le Radium* will continue admirably to serve the new science of subatomic phenomena. At the request of M. Danne I am receiving papers and subscriptions at this address.

GERALD L. WENDT
UNIVERSITY OF CHICAGO

## SCIENTIFIC EVENTS

### EXPEDITIONS FROM THE UNIVERSITY OF CALIFORNIA

JUST returning from a four month's expedition through southeastern Alaska and northern British Columbia, a party of scientific men under the leadership of Dr. Joseph Grinnell from the University of California has brought about 1,200 specimens of birds and mammals representing nearly all of the birds and smaller species of mammals inhabiting the country, as well as a few examples of the larger mammals, such as mountain goat, grizzly bear, wolf and beaver. Some amphibians, plants, and a large number of photographs also were brought back.

H. S. Swarth, curator of birds, and Joseph Dixon, economic mammalogist, assisted at times by local guides and hunters, comprised a party which started from Wrangell, Alaska, and went to Telegraph Creek, British Columbia, a distance of 170 miles from the coast and at the head of navigation on the Stikine River, traveling by the river boat which runs on the stream during the five months of the year when it is free of ice. On the return trip down stream camps were established at various points and explorations were pursued.

Reports from the party indicate that the coast of southeastern Alaska is characterized by extremely heavy rainfall while the interior toward the source of the Stikine River is relatively arid.

The country about the upper Stikine River for a long time has been a mecca for big game hunters, this region being one of the few remaining places in North America where a variety of such game may be pursued with a fair assurance of success. But this year's expedition of the Museum of Vertebrate Zoology of the University of California is said to be the first party of naturalists to visit and care-

fully study the smaller animal life along certain routes of the Stikine River region. Extensive collections are said to have been made at points heretofore not visited by any naturalist.

It is planned later to publish a report based on this material with the field notes written during the summer months. Such a publication will be in the nature of a continuation of other reports based on previous explorations of the museum some years ago covering investigation of the animal life of the northwest coast of North America. Previous trips have covered much of the mainland and most of the islands off the coast of southeastern Alaska.

Miss Annie M. Alexander, founder of the Museum of Vertebrate Zoology of the University of California, made possible this year's work as well as past years' investigations.

## JOINT MEETING OF THE AMERICAN PHYSICAL SOCIETY WITH THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

A JOINT meeting of the American Physical Society and the American Institute of Electrical Engineers, arranged by the Committee on Technical Physics, will be held in Philadelphia, at the Bellevue-Stratford Hotel, on Friday and Saturday, October 10 and 11, 1919.

The Technical sessions on Friday will be held in the Clover Room of the Bellevue-Stratford and the subscription dinner Friday evening in the Stratford Room. The technical sessions on Saturday will be held at the works of the Leeds and Northrup Company, where a complimentary luncheon will be served by the company.

The program is as follows:

FRIDAY, 9:00 A.M.

*Session of the Physical Society*

*Atomic structure,* papers by P. W. Bridgeman, of Harvard University, and by Irving Langmuir, of the Research Laboratory of the General Electric Company. There will be a formal discussion by Saul Dushman and others.

FRIDAY, 2:30 P.M.

*Session of the A. I. E. E.*

1. *The arrangement of atoms in metals,* by A. W. Hull, of the General Electric Research Laboratory. An X-ray study of crystal structures, illustrated with models of crystals.
2. *The oscillating vacuum tube as a generator of electrical power,* by J. H. Morecroft and H. T. Friis, both of Columbia University. Lantern slides of oscillograph records.
3. *Electromagnetic induction,* by J. S. Barnett, of the Department of Terrestrial Magnetism, Carnegie Institution.
4. *Piezo-electrical effect,* by A. M. Nichols, of the Western Electric Company. (Demonstration.)

FRIDAY, 6:00 P.M.

*Subscription Dinner*

Five minute talks by the presidents of the two societies.

FRIDAY, 8:00 P.M.

Technical papers by H. A. Bumstead, of Yale University, and J. J. Carty, Vice-president of the American Telephone and Telegraph Company.

SATURDAY MORNING

*Session of the Physical Society*

Inspection of the Leeds and Northrup laboratories.

Several semi-technical papers will be presented by the physicists of the Research Laboratories of the Leeds and Northrup Company.

SATURDAY NOON

Complimentary luncheon by the Leeds and Northrup Company.

Automobile ride around Germantown.

SATURDAY AFTERNOON

A regular session of the Physical Society will be held on Saturday afternoon in the auditorium of the Leeds and Northrup Company, for the reading of miscellaneous papers. Members wishing to present papers should send abstracts, *ready for publication,* to the secretary at once. Probably the program for this session will not be ready for distribution in advance of the meeting.

There will probably be opportunity for technical excursions to the Welsbach factory or a steamer ride on the Delaware River to Chester at 10:30 Friday morning. The steamer ride will be available Saturday morning also.

Other meetings of the American Physical Society will be held in Chicago on November 28 and 29, and in St. Louis in the week of December 29 to January 3. Members are urged

to submit abstracts of papers well in advance of the date of the meeting at which they are to be presented.

DAYTON C. MILLER,
*Secretary*

CASE SCHOOL OF APPLIED SCIENCE,
CLEVELAND, OHIO

### THE RED CROSS AND PROFESSOR RICHARD P. STRONG

DR. RICHARD P. STRONG, professor of tropical medicine at the Harvard Medical School, sailed on October 2 for Europe, where he is to be general medical director of the League of Red Cross Societies, with headquarters in Geneva. He has been granted leave of absence for a year by Harvard University.

The league is a new international association of the Red Cross planned to act as a central agency for the improvement of public health, the prevention of disease and the mitigation of suffering throughout the world. It will also serve in cases of national or international disaster. Another of its purposes is to promote the welfare of mankind by furnishing a medium for bringing within the reach of all the peoples the benefits to be derived from present known facts, new contributions and medical knowledge and their application.

Henry P. Davison is chairman of the board of governors of the league, and the director-general of the league is Lieutenant-General Sir David Henderson, of Great Britain. The public health work and general medical activities of the league will be under the direction of Dr. Strong. In this position he will be the executive at Geneva responsible for stimulating the medical work of the various Red Cross societies and putting the latest medical information at the disposal of each of them. His office will be the general headquarters of the fight against epidemic diseases, such as that of influenza, which recently swept across the world, and particularly against the terrible typhus and other tropical epidemics.

Dr. Strong is fitted for this task by knowledge and experience. He went to the Harvard Medical School in 1913 with a distinguished record as a student of tropical diseases in the Philippine Islands, where he had begun as an army medical officer. In 1915 he was the leader of the international corps of workers who combatted the typhus epidemic in Serbia which had taken many thousands of lives.

After the United States entered the war in 1917, Dr. Strong was in charge of the Division of Infectious Diseases of the American Expeditionary Forces. He has received the Distinguished Service Medal of the American Expeditionary Forces, the British Order of Commander of the Bath, Officer of the French Legion of Honor and the Chinese Striped Tiger, and has been made Grand Officer of the Serbian Cross of St. Salva.

## SCIENTIFIC NOTES AND NEWS

THE autumn meeting of the National Academy of Sciences will be held on November 10, 11 and 12, at Yale University, New Haven, Connecticut. Announcement of the arrangements for the meeting will be made later by the local committee.

DR. R. W. WOOD, professor of physics in the Johns Hopkins University, has been elected a foreign member of the Royal Society, London.

THE nomination of Mr. James R. Riggs, as assistant secretary of agriculture, has been confirmed by the Senate.

DR. D. G. BYERS, of the University of Washington, recently a captain in the Chemical Warfare Service in Washington, has been appointed chief of the division of chemistry of the Bureau of Soils.

MAJOR DOUGLAS JOHNSON, professor of physiography at Columbia University, has returned from Paris where he served as chief of the Division of Boundary Geography on the American Commission to Negotiate Peace, and as a member of different international territorial commissions.

RUSSELL L. CECIL, M.D., lately major, M. C., U. S. Army, William A. Perlzweig, Ph.D., lately lieutenant, Sanitary Corps, U. S. Army, and Mr. G. I. Steffen, lately lieutenant, Sanitary Corps, U. S. Army, have been engaged by the U. S. Public Health Service to carry out experimental investigations on influenza and pneumonia. The work will be conducted

in the research laboratories of the Department of Health of New York City under the direction of Dr. Cecil.

Major R. G. Hoskins, who has been for the past four months in charge of the Section of Food and Nutrition of the Surgeon-General's Office, has received his discharge from the service. He will spend the current academic year studying at the Johns Hopkins Medical School.

Professor F. K. Richtmyer is on sabbatic leave for a year from Cornell, devoting a part of his time to research in the Research Laboratory of the General Electric Company, at Schenectady.

Mr. Joseph Mailliard, honorary curator of ornithology, of the California Academy of Sciences, left San Francisco on September 15 with his assistant, Mr. Luther Little, to collect birds in Mendocino county, California. Mr. Mailliard secured a representative collection from this territory in June and now is covering the same ground to note seasonal changes and variations.

Dr. J. A. LeClerc has resigned from the Bureau of Chemistry, U. S. Department of Agriculture, and is now with the Miner-Hillard Milling Company of Wilkes-Barre, Pennsylvania.

We learn from the *Journal* of the American Medical Association that the University of Pisa recently organized a festal meeting to honor the fiftieth professional anniversary of Professor G. Romiti of the chair of anatomy. A marble portrait bust was unveiled, and Professor Romiti presented the university with his valuable library on anatomy

The first lecture of the series of the Harvey Society will be given at the New York Academy of Medicine on October 18, by Lieutenant-Colonel George Dreyer, M.D., professor of general pathology, Oxford University, on "Biological Standards and their Application to Medicine." The second lecture of the series will be given on October 25 by Dr. H. H. Dale, of the Lister Institute of Preventive Medicine, London, on "Shock."

Dr. August Hoch, who was for seven years the director of the Psychiatric Institute on Ward's Island, died on September 23, in San Francisco.

A legacy of $60,000 has been made by the late Dr. Rizzi, physician in chief of the Ospedale Maggiore at Milan, to found an institute for the research and practise of biochemistry.

The legislature of Alabama has passed the Alabama Mental Deficiency bill which appropriates $200,000 for the establishment of the Alabama Home for Mental Inferiors at Tuscaloosa in connection with the Bryce Hospital. As a part of the campaign for securing the passage of this measure, Dr. W. D. Partlow, superintendent of the Alabama Insane Hospitals, and Dr. Thomas H. Haines, field agent for the National Committee for Mental Hygiene, made a careful mental survey of the four industrial schools of the state last May. This was a cooperative piece of work of the Alabama State Board of Health and the National Committee for Mental Hygiene. One hundred and twenty-nine of the six hundred and fifty-four juvenile delinquents in the schools were found to be so defective in mental ability as to demand institution care of a custodial sort for their proper management. These facts proved a potent argument in securing the appropriation.

The Fédération française des sociétés de sciences naturelles has been formed consisting of thirteen society units: les Sociétés Zoologique, Entomologique, d'Acclimatation, de Pisciculture; l'Association des Anatomistes; les Société de Botanique, de Mycologie, de Pathologie végétale; la Société philomatique; la Société géologique; la Société des Naturalistes parisiens; la Société de Chimie biologique. It is proposed to establish five categories for the purpose of bibliographic documentation: (1) botany; (2) anatomy and embryology; (3) zoology; (4) general biology, and (5) physiology.

## UNIVERSITY AND EDUCATIONAL NEWS

A new mechanical engineering building and a new physics building are nearing completion

at the Agricultural and Mechanical College of Texas. The Texas Legislature has recently provided $250,000 for an agricultural building also. Plans and specifications are now being drawn for this building which will be started next summer.

THE Georgia Legislature, at its recent session, increased its appropriation for the medical department of the State University from $30,000 to $55,000. Of the new funds, the sum of $20,000 is to be used to establish a course in Public Health and Hygiene, and the sum of $5,000 is to be added to the general income of the school.

IN the medical department of the University of Pennsylvania Dr. William H. F. Addison has been made a full professor of histology and embryology; Dr. Oscar H. Plant has been promoted to a full professorship in pharmacology; Dr. Byron M. Hendricks and Raymond Stehle have been promoted to assistant professorships of physiologic chemistry.

DR. HERBERT S. LANGFELD has been appointed director of the psychological laboratory of Harvard University and Dr. L. T. Troland and Dr. Floyd H. Allport, have been appointed instructors in psychology. Dr. William McDougall, whose appointment as professor of psychology was reported in a recent issue of SCIENCE, will take up his work at the beginning of the next academic year.

THE department of botany of Kansas State Agricultural College has been reorganized and is now carrying on its work in the college and experiment station under the name of the department of botany and plant pathology. L. E. Melchers, for two years acting head of the department, has been made professor of plant pathology and head of the department. E. C. Miller, formerly associate professor, has been promoted to be professor of plant physiology. The other members of the department are Assistant Professors W. E. Davis and F. C. Gates, Instructors H. H. Haymaker and Nora E. Dalbey, and Assistant Dorothy Cashen.

THE new chair of physical education at the Agricultural and Mechanical College of Texas has been filled by Dr. W. J. Young, who held the rank of captain in the National Army during the war. Previously he was director of physical education in the University of Maine. Professor D. Scoates has been appointed head of the department of agricultural engineering to succeed Professor R. A. Andree, who has resigned.

GEORGE P. BACON, of Simmons College, has been appointed to succeed Dr. H. H. Marvin, of Tufts College, who is going to the University of Nebraska, as head of the department of physics. Professor Bacon is to be chairman of the department of physics at Tufts College.

DR. R. E. LOVING, head of the department of physics in Richmond College, has been granted leave of absence for the current session, which he will spend doing special work in Cornell University. C. H. Willis, late of the Signal Corps, A. E. F., and V. E. Ayre, from the Bureau of Standards, have recently been appointed, respectively, acting professor and asistant professor in the department.

LIEUTENANT HORACE A. HOLADAY, Sanitary Corps, nutrition officer at the port of embarkation at New Port News, Va., formerly assistant professor of chemistry at the University of Idaho, has been appointed professor of physiological chemistry and head of the division of food and physiological chemistry at North Dakota Agricultural College.

RALPH J. GILMORE, Ph.D. (Cornell), of Huron College, has been appointed head of the department of biology of Colorado College, succeeding Dr. E. C. Schneider, who becomes head of the department of biology at Connecticut Wesleyan College.

DR. JOHN L. SHELDON, who has had charge of the work in botany and bacteriology in the West Virginia University for the past sixteen years, has resigned. The university has also lost recently the heads of the departments of animal husbandry, agronomy, horticulture, public speaking and philosophy.

DR. J. G. FITZGERALD, associate professor of hygiene, University of Toronto, and director of the Connaught Antitoxin Laboratories in the

same institution, has been appointed professor of hygiene, succeeding Dr. John A. Amyst, who has been appointed deputy minister of health in the Federal Department of Health, Ottawa. Dr. Fitzgerald will continue to act as director of the Connaught Laboratories.

Professor L. Bard, who for twenty years has held the chair of clinical medicine at the University of Geneva, has accepted a corresponding position at the University of Strasburg.

## DISCUSSION AND CORRESPONDENCE

### EMIL FISCHER AFTER THE WAR

The reading of Professor Harrow's highly appreciative account, in Science of August 15, of Emil Fischer and his work recalls to me a meeting that I had with Fischer in February of this year in Berlin. I have referred, in a recent little book[1] about Germany and Germans since the war, to a conversation which Dr. Alonzo E. Taylor and I, officially representing Mr. Hoover and the American Food Administration, had in our rooms in the Hotel Adlon in Berlin one Sunday morning last February with three distinguished German scientific men. The conversation was primarily an interview with these well-informed men on the subject of the German food situation; we were there to try to find out just what food importations were immediately necessary to keep the German people from further suffering and danger. We had talked with responsible officials of the new German government, and been presented with various official statements by them, but we wanted to check these by any unofficial information we could obtain. Hence this Sunday morning meeting in our hotel rooms with Karl Ballod, Germany's foremost economic statistician, Nathan Zuntz, one of her first animal physiologists, and Emil Fischer, her great organic chemist. But as scientific and university men our talk ran rather freely and frankly, and touched other matters than food statistics.

It was a conversation of fascinating interest, with Fischer the dominant figure in it. Ballod, tall and spare, of serious mien, was rather restrained and precise; Zuntz, small and active, even smiling, was perhaps a little exaggeratedly gracious; Fischer, heavy-bodied, vigorous and emphatic, was easy and with no trace of self-consciousness. All agreed on the terrible seriousness of the situation but each had special views as to the more pressing necessities and means of meeting them. All declared that they had realized for more than a year the practical certainty of Germany's ultimate collapse, but replying to our questions as to why they had not used their knowledge of the fatal food and general economic situation to prevail on the German authorities to try to end the war while an ending might be made that would be less disastrous than any that could come after a further persistence in the struggle, all declared their complete helplessness to exercise a sufficient influence on rulers or people. "We should not have been heard at first and before we could push the matter to a general hearing we should have been in prison or have had to flee the country to avoid it. Remember Forster and Nicolai and Muehlon," they said.

They told of their own difficulties to find food for themselves and families, despite their sufficient financial means, and then spoke especially of the terrible hardships of their less well paid colleagues and small-salaried assistants. Fischer, in particular, revealed his sympathy for his distressed helpers, while all three spoke of the serious handicap the situation had been on the work in the scientific institutions with which they were affiliated.

But while Ballod looked on the future darkly, and Zuntz with no confidence, Fischer was more sanguine. He said: "We have got to start again, but we *can* start." When we told him that both America and England had made some headway during the war period in the production of dyes and optical glass and some other things that had been a monopoly of Germany in the days before the war, and that we should be far more independent in such ways than we had been before, Fischer was silent a moment, thoughtful and serious of face, but soon looked up and said: "Well, that

[1] "Germany in the War and After," 1919, Macmillan Co., N. Y.

sounds rather bad; but"—and he smiled confidently and made a large gesture with his open hands—"we'll make something new that you'll have to have." It was a fine confidence, and characteristic of the wonder-worker who had all his life been making "something new."

VERNON KELLOGG
NATIONAL RESEARCH COUNCIL,
WASHINGTON

### THE AURORAL DISPLAY OF SEPTEMBER 18

ON the evening of September 18, shortly after eleven o'clock and continuing until after twelve, there was the most unusual manifestation of aurora borealis at Fargo that we have ever witnessed. It consisted of an intensely luminous band some five degrees in width, extending through the zenith from one horizon to the other. The eastern end was some fifteen degrees south of east and the western end a corresponding distance north of west. The band was very uniform in width and intensity, though somewhat wider and more intense at the zenith. It had the general appearance of an intense shaft of light from a powerful searchlight, except for its direction and position. At the same time there was a considerable manifestation of aurora at the north, but between that and the band spoken of there was no illumination.

We have never had our attention called to a like phenomenon and we are wondering if it was observed at other points.

C. B. WALDRON

### AURORAL DISPLAYS AND THE MAGNETIC NEEDLE

IN connection with the auroral displays of August 11 last, mentioned in these columns on August 22, it may be of interest to mention the behavior of the magnetic needle at Omaha at the time. The wire chief of the Western Union Telegraph Company called me by telephone that morning and said that there was very considerable and unusual trouble with earth currents over the wires between Chicago and Cheyenne as far south as Kansas City. Upon this notification I began to observe the behavior of the magnetic needle. I have two fine needles about 4 inches long, one in a transit with a full circle, and the other in a plane table with a range of only 5 degrees on either side of the zero. As the first trembled too much on account of the mechanical vibrations of the floor of the room, I confined my attention to the second. I saw the north end of the needle first creep a few degrees to the west, and then by slow stages advance as far as five degrees to the east. Although I kept myself as motionless as possible, I saw the needle swing violently to the west, the full range of the case, through an arc, therefore, of more than 10 degrees, so that it rebounded by its impact against the side. This was at about 5 P.M., Summer Central Time.

A double track electric railway ran north and south about 150 feet to the east of the needle. At almost its nearest point there is a break in both trolley lines, serving as a division point between two sections. This meant that the current supplied over the trolley to the cars was suddenly interrupted whenever the cars came to this division point. I watched the needle very closely at these moments to see whether this feature might account for its oscillations, but could not find the least connection. The next day the needle was as quiet as if it had been riveted to its case.

WILLIAM F. RIGGE

## QUOTATIONS

### SCIENCE AND THE PRESS

Is it possible for the newspaper press to be a useful intermediary between the investigator and the public? Mr. Chester H. Rowell, a well-known American journalist, discussed the question at the recent Pacific meeting of the American Association for the Advancement of Science. Neither here nor in the United States can there be any doubt as to the advantage of widespread knowledge of the methods, the objects, the results, and the personalities of science. Even during the war we suffered much from misapprehension of these. Science was called on to produce, and did produce, magical results as a conjuror produces rabbits from his sleeve. There was no appreciation of the long training, the elaborate

apparatus, and the skilled methods required for these feats. And too often the specifications of the inventions were amended by ignorant officials, and their application entrusted to unskilled persons. Such costly errors can be avoided in the future, and the requisite support given to the deliberate pursuit of science, only if the nation generally learns to understand and sympathize with scientific men and scientific work.

Mr. Rowell is confident that the popular press is indispensable for any general contact with a wide public. He offers advice, based on American conditions, as to how such a result may be accomplished. He distinguishes between the daily newspapers and the Sunday newspapers. The latter vehicle is less sharply marked off in this country than in America, Germany and Vienna, where the vast bulk of the Sunday issues overwhelms those who make first acquaintance with them. Mr. Rowell says that it is necessary to "print an excessive amount of reading matter, to float the advertising." The news will not go round, and so, as a desperate resort, the editors have recourse to literature, science, and the arts. Scientific men are given this friendly advice: the Sunday papers will take anything, even science. But entrance to the columns of the daily newspapers is another matter. That goes by merit. The test of merit is that the "copy" is news. There is no hope, says this expert, of getting things printed as news because they are "useful or useless, beneficial or injurious." "The eternal verities are not news, though a temporary or adventitious fact regarding them may be." The reference, we repeat, is to conditions in the United States, but they may be worth noting by the English public, who are more responsible for the contents of the newspapers they read than they perhaps realize.—The London *Times*.

## SCIENTIFIC BOOKS

*Starfishes of the Philippine Seas and Adjacent Waters.* By Walter K. Fisher. United States National Museum Bulletin 100. Washington, Government Printing Office. 1919. Pp. xxi + 712, 156 pls.

For several years, students of echinoderms have been awaiting with some impatience the appearance of Fisher's complete report on the sea-stars collected by the *Albatross* in the East Indian region, between December, 1907, and December, 1910. Several preliminary papers have appeared, in which most of the novelties were described, but it was well understood that the full report would be a monograph of the greatest importance to the morphologist and zoogeographer as well as to the systematist.

This expectation is wholly justified by the present volume, with its wealth of illustration and its ample discussions of structural and taxonomic problems. The brief preface, besides the customary acknowledgments for help received, recounts the chief facts as to number of species collected, the number of novelties and the new genera and subgenera represented. An introduction of some twenty pages gives a brief historical sketch of our knowledge of Philippine sea-stars and then plunges into a detailed analysis of the distribution of the species and the relationships of the fauna. There is a very large amount of zoogeographical material presented here, but the obvious criticism may be made that the treatment is too exclusively analytical. Probably, in view of the fact that the large and highly important material collected by the *Siboga* in the Dutch East Indies is as yet but partially studied, Dr. Fisher felt that any conclusions drawn from the *Albatross* material alone would be premature and almost certainly liable to revision. The introduction closes with two pages of analysis of the composition of the *Albatross* collection and one wonders why this is placed at this point rather than in connection with the similar data presented in the preface. Following the introduction is an important list of the sea-stars of Celebes and the Moluccas, with the authority given for each record, and then is given the list of *Albatross* stations at which sea-stars were taken.

Examination of this station list reveals some interesting facts. The largest number of species taken at any one station was *nine*

and that occurred but once. This was at station 5648 in Buton Strait, Celebes, in water 559 fathoms deep, and it is very remarkable that all of the nine species were new to science, three represented new genera, and of only one was there more than a single specimen! Surely this is one of the most notable dredgings of sea-stars ever made. At two of the *Albatross* stations, *seven* species of sea-stars were taken, but these were both in shallow water (9 or 10 fathoms) in the Tawi Tawi group; in one case, all were representatives of previously known species; in the other there were two new species, one representing a remarkable new genus. At each of two stations in the Philippines, 5482 at 67 fathoms and 5536 at 279 fathoms, half a dozen species were taken.

The remainder of the volume is occupied with the detailed account of 182 species and 10 subspecies, all but two of which were taken by the *Albatross*. Only one or two are here described for the first time, but 134 were new when taken and were originally described from this collection. Many of these are notable for structural peculiarities and 18 represented new genera, while others made the segregation of 6 additional genera or subgenera desirable. The method of treatment is admirable; a brief diagnosis of each species is followed by a description, more or less detailed according to the condition of the material and the importance of the species. If young specimens are available, a special paragraph is given to them, the features in which they differ from the adult being pointed out. The museum number of the holotype and the exact position of the type-locality are then given, followed by a statement of the known distribution and a list of the specimens examined. Last, and oftentimes most important of all, is a paragraph of "Remarks," in which is discussed the relationships of the form, its diversities and peculiarities, and any nomenclatural or distributional facts that need elucidation.

Many of the families and genera are treated in the same thoroughgoing way and in these discussions, Dr. Fisher's exceptional knowledge of sea-stars and of the literature concerning them is well shown. But more than this is revealed—clear thinking, openmindedness and a perfectly balanced judgment, that are very attractive and most convincing. The writer has no hobbies to ride and no hypotheses to defend; he is obviously seeking all the available facts and only the deductions which may reasonably be drawn from them. He is always seeking to throw light on the subject in hand and to unsnarl the tangles due to lack of knowledge or to misinformation. The frequent and carefully detailed keys to species and genera well illustrate this and will prove of constant service to other workers.

The recognition of subspecies, in the ornithological sense of forms passing by gradation into the typical form but occupying a different geographical area, is something of a novelty in the taxonomy of echinoderms but is of course the natural result of increasing knowledge. The question which may fairly be raised is whether we have sufficient data and material as yet to warrant their recognition. Probably we have in some cases, but in others it were well to be cautious. Thus Fisher recognizes the typical form and three subspecies (using trinomials as in ornithology) of *Asterina coronata*, of which very few specimens are as yet known; it is quite possible that we are here dealing with a somewhat variable species, and a large amount of material will show that there is no correlation between the diversities and the distribution.

In typography, arrangement and illustration the volume is very satisfactory. It is too bad that "starfishes" is used in the title when Dr. Fisher is known to be an advocate of "sea-stars" as a substitute for the more familiar word. No doubt the editor considered "starfishes" a more "popular" title but it is so lamentably inaccurate, it is a pity Fisher could not have had his way in the matter. It is a little odd that neither term seems to be used in the text; at any rate, I have found neither; but once the phrase is used, "specimens of Asteroidea"! There is a good table of contents at the beginning of the volume, and at its end, a very full and useful index. The plates are half-tones, printed on both sides of the paper, interleaved

with pages of explanatory text; the arrangement is unusual and at first sight not attractive, but as soon as one has become accustomed to it, it is found to have much to commend it. The photographs from which most of the plates were made are exceptionally clear and hence the necessity of using halftones is not so unfortunate as might be. The impossibility of using a lens on such plates is counterbalanced by the numerous drawings of the essential details, so that every important species is amply illustrated. The volume is a credit to the Government Printing Office, as well as to the National Museum, and it amply confirms Fisher's position as chief among students of the Asteroidea.

Hubert Lyman Clark

## NOTES ON METEOROLOGY AND CLIMATOLOGY

### AGRICULTURAL METEOROLOGY

Since weather is a prime factor in crop production, the study of agricultural meteorology is not lagging in this great farming country. It is only comparatively recently, however, that the U. S. Department of Agriculture has made available a large amount of reliable information about crops in such a form as to be used readily for comparison with weather and climate. For six years there has been a division of agricultural geography, Mr. O. E. Baker in charge, the principal object of which has been to issue by sections a carefully wrought "Atlas of American Agriculture." An advance rainfall map of the United States,[1] and advance folios on Frost and the Growing Season,[2] and on Cotton[3] have appeared, as well as extensive graphic contributions in the Year Book of the U. S. Department of Agriculture, 1915,[4] 1916,[5] 1917[6] and 1918,[7] and a fine small atlas on "The Geography of the World's Agriculture."[8] The Weather Bureau's contribution to the Atlas of American Agriculture has been the material for the climatic section, of which there is much still to be published; and now its division of agricultural meteorology, Professor J. Warren Smith, in charge, is pushing forward several lines of investigation on the influence of weather and climate on dates of planting and harvesting crops and on crop yields,[9] and on the occurrence of damaging frosts and the possibility of forecasting them from weather conditions the day before.[10] Furthermore, with the excellent crop maps now available, Professor R. DeC. Ward, of Harvard, has written an interesting interpretation of the "Larger relations of climate and crops in the United States." Some of the recent Weather Bureau contributions to agricultural meteorology will be reviewed briefly here.

*Relation between Vegetative and Frostless Periods* (by J. B. Kincer, *Mo. Weather Rev.*, Feb., 1919, Vol. 47, pp. 106–110, 5 figs., 8 charts). Since 6° C. (about 43° F.) is gen-

[1] Reproduced in *Mo. Weather Rev.*, July, 1917, and discussed on pp. 338–345 by R. DeC. Ward. (Reviewed in Science, N. S., Vol. 48, July 19, 1918, pp. 67–71.)

[2] Reviewed in *Mo. Weather Rev.*, November, 1918, pp. 516–517, and in *Geog. Rev.*, May, 1919, pp. 339–344. (Reprinted, *Sci. Am. Suppl.*, August 23, 1919, pp 117–118.)

[3] The climatology of the cotton plant is being reprinted in the *Mo. Weather Rev.*, July, 1919, and is reviewed in *Geog. Rev.*, May, 1919, pp. 348–349.

[4] "A Graphic Summary of American Agriculture," by Middleton Smith, O. E. Baker and R. G. Hainsworth, pp. 329–403, 4 graphs, 78 maps.

[5] "A Graphic Summary of World Agriculture," by V. C. Finch, O. E. Baker and R. G. Hainsworth, pp. 531–553, 74 figs.

[6] "A Graphic Summary of Seasonal Work on Farm Crops," by O. E. Baker, C. F. Brooks and R. G. Hainsworth, pp. 537–589, 90 figs. Abstracted and discussed in *Mo. Weather Rev.*, May, 1919, pp. 323–327.

[7] "Arable Land in the United States," by O. E. Baker and H. M. Strong, Separate 771, 10 pp., 10 graphs, 9 maps.

[8] By V. C. Finch and O. E. Baker (Office of Farm Management, U. S. Dept. of Agric.) Washington, 1917. Reviewed in *Jour. of Geog.*, January, 1919, pp. 39–40.

[9] A thorough discussion of the effect of weather on the yields of corn, potatoes and winter wheat, by J. Warren Smith, is published in Proc. Second Pan-Am. Sci. Cong., 1915–16, Vol. 2, pp. 75–92: see review, in *Geog. Rev.*, Vol. 4, 1917, p. 317.

[10] "Predicting Minimum Temperatures," by J. Warren Smith, *Monthly Weather Review*, August, 1917, pp 402–407.

erally considered as the temperature at which most plant growth begins in spring and ends in fall, Mr. Kincer made maps showing the advance and retreat of the isotherm of 43° F. in the United States in spring and fall and of the length of the period between the date in spring when the normal mean daily temperature rises above 43° F. in spring and falls below it in autumn. This period he called the "vegetative period." These maps were then compared with the corresponding maps of last killing frost in spring, first killing frost in autumn and average length of the growing season (*i. e.*, between killing frosts); and other maps were made to show the differences, which amount to about ten days in the North and thirty or more in the South, the vegetative period being the longer. Other maps show that the normal mean daily temperature on the average frost dates just mentioned are for most of the country between 50° and 57° F.; on the Great Lakes, the Pacific, and the Atlantic north of Hatteras, however, the corresponding temperatures are below 50° F. Mr. Kincer points out that protective measures against frost damage may be well worth while in the South, where the vegetative period usually continues for weeks after the first killing frost, but not in the North, where, in autumn for example, low temperatures would soon stop the growth of vegetation which might have been protected from the first killing frost.

*Temperature Influence on Planting and Harvest dates* (by J. B. Kincer, *Mo. Weather Review*, May, 1919, Vol. 47, pp. 312–323, 20 figs., inclu. maps).—This is based largely on a study of the maps in "A Graphic Summary of Seasonal Work on Farm Crops,"[6] in comparison with temperature data.

It is suggested that the mean temperature at which planting of a given crop can be accomplished be used as a base, or starting point, for any method that may be employed for temperature summation, instead of a general base for all crops (*e. g.*, 6° C.). . . . Spring wheat seeding usually begins . . . when the normal daily temperature rises to 37° or 40° F. The corresponding temperature for spring oats is 43°, for early potatoes, 45°, for corn 55° and for cotton 62° F. Cotton and corn are warm-weather crops and the areas in which successful production on a commercial scale can be accomplished are limited principally by both the general temperature conditions and the temperature at which planting may be accomplished. There is a close relation between spring temperatures and the condition of these crops to certain dates in the early stages of growth.

*Alfalfa Hay and Seed Growing in South Dakota and Utah* (separate papers by H. N. Johnson of Rapid City, S. Dak., and J. C. Alter of Salt Lake City, *Mo. Weather Rev.*, May, 1919, Vol. 47, pp. 328–332, 5 figs.).—"Alfalfa seed is usually produced [in S. Dak.] when conditions are such as to retard the maturing of the first hay crop, and then in paying quantities only when there is a comparative shortage in the moisture supply, hence the weather conditions determine whether the second crop shall be cut for hay or left for seed. If there is considerable rainfall, the second crop is usually cut for hay, and a third crop is frequently possible." As rainfall conditions fluctuate widely on the Great Plains, the western South Dakota alfalfa farmer has in such an arrangement a fine insurance against drought or unusual amounts of rainfall. In Utah the seed-crop, which follows a cutting for hay, needs special weather conditions for the best yields: there should be

sufficient moisture during its early growth to produce a vigorous, healthy plant, but the weather should be dry and not too warm while the plants are in bloom. The dry spell must not be too extended, however, as the seed must have sufficient moisture while setting to give it size and weight. It takes nearly twice as long to grow and mature a seed crop as it does a hay crop. As the seed crop is not always ripe on the occasion of the first killing frost in fall, considerable importance is attached to frost and minimum temperature forecasts. On the receipt of frost warnings, the usual practise is to cut as large an area as possible; but as the first cold period is often followed by several weeks of fine ripening weather, and as the value of the seed is said to increase at the rate of nearly $5 an acre each 24 hours when ripening, efforts should be made to protect the plants from frost damage without cutting.

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## SPECIAL ARTICLES

### WHITE CORN VS. YELLOW CORN AND A PROBABLE RELATION BETWEEN THE FAT-SOLUBLE VITAMINE AND YELLOW PLANT PIGMENTS

As the importance of the vitamines in the physiological economy of the animal is coming to be appreciated, observations on their occurrence and their distribution in nature are being rapidly accumulated in various laboratories. As is to be expected, with data on vitamine distribution available, there is a growing inclination to deduce therefrom, not only evidence as to their possible rôle in living organisms, but also a suitable working hypothesis enabling one to predict in an unknown whether the amount of vitamine is liable to be large or small. Furthermore, from the viewpoint of the chemist, it scarcely needs to be emphasized what a step in advance it would be if from their occurrence in nature an idea could be obtained as to their possible chemical character.

We are still far distant from this goal in the case of the anti-scorbutic and anti-neuritic vitamines, but in the case of the fat-soluble vitamine, the mere fact—as its name indicates—that it is soluble in fats and also its solubility in many fat solvents excludes from consideration many compounds.

Two years ago the writer experienced some difficulty in getting rats to rear their young on a ration which, to a considerable extent, consisted of corn. Failure was often indicated by an inflammation of the eyes—a xerophthalmia, which Osborne and Mendel[1] first indicated as evidence of a deficiency of the fat-soluble vitamine. No further attention was paid to this difficulty beyond modifying the ration to increase its content of this dietary essential. Later, however, rats were again put on a similar ration and no difficulty was experienced. With many other apparent inconsistencies arising in a colony of a thousand animals, and all of them bearing investigation no immediate attention was given to this matter.

During the course of the past year a considerable amount of work dealing with the occurrence of the fat-soluble vitamine in roots was completed. It was indicated that, while the colored roots such as carrots and sweet potatoes are rich in this dietary essential, sugar beets, mangels, dasheens and Irish potatoes contain little or none of it. It was then recalled that at the time that the difficulty with female rats to rear their young had been observed, it had been impossible to obtain sound yellow corn on the local market and white corn had been used instead. This had been done in a part of the stock colony and as the conditions for its maintenance are fairly well standardized and not always under close personal supervision the relation between the slight modification in the ration and the disastrous results had not been detected.

It has now been conclusively demonstrated with eight different varieties of corn which are extensively grown in the middle west, that while white corn contains no demonstrable amounts of the fat-soluble vitamine, yellow corn may contain sufficient amounts to allow normal growth and reproduction in the rat. One rat has successfully reared her young after having been fed yellow corn suitably supplemented with vitamine-free protein and salts for seven months. On white corn, similarly supplemented, young rats usually die in three months with the typical symptoms of a fat-soluble vitamine deficiency.

These relations suggested the possibility of correlating other instances of the simultaneous occurrence of the fat-soluble vitamine and yellow plant pigments. We have at hand the interesting observation of Osborne and Mendel[2] that while the oleo oils contain the vitamine, the solid beef fats do not. They state specifically that the oleo oils were yellow while the solid fats were colorless. Furthermore, they were also able to separate the butter fats by fractional crystallization into an active fraction of the liquid fats—which was yellow—and an inactive fraction—which was colorless.

[1] T. B. Osborne and L. B. Mendel, *Jour. Biol. Chem.*, 16, 431, 1913.

[2] T. B. Osborne and L. B. Mendel, *Jour. Biol. Chem.*, 20, 379, 1915.

In an investigation of the nutritive properties of commercial oleos and their ingredients, the writer and coworkers[3] have found a considerable difference in their vitamine content. It is significant that of the oleo oils those most highly pigmented were also the richest in fat-soluble vitamine and those least pigmented were the poorest. This, in view of the present prevailing conception of the importance of the vitamine content of certain fats in the diet, is a matter of such great economic significance that comment on it is reserved until the investigations now in progress shall have been completed. It is mentioned here merely to indicate why it is considered possible that the fat-soluble vitamine may be one of the yellow pigments or a closely related compound.

In scores of feeding experiments in which butter fat as prepared from ordinary butter has been used as the source of the fat-soluble vitamine we have repeatedly observed variations in the vitamine content. It has not been possible to correlate this with the degree of pigmentation—which is well known to vary with the feed and the breed of the dairy cow—as the amount of natural pigment present had been concealed by the addition of butter color. One fact however appears particularly significant, and that is, that when butter fat is heated its vitamine is destroyed and simultaneously there occurs a destruction of its pigment.[3] Whether this is an accidental coincidence or one and the same thing remains to be seen.

From the evidence submitted it appears reasonably safe, at least as a working hypothesis, to assume that the fat-soluble vitamine is a yellow plant pigment or a closely related compound, which view, moreover, is strengthened by the fact that we know through the work of Palmer and Eckles[4] of the inability of the animal to synthesize the yellow pigments carotin and xanthophyll. From its occurrence in butter, in leaves, in carrots and in other materials known to be rich in carotin, it might be concluded that we were here concerned with carotin. Some data, that we have accumulated have answered this in the negative and it has been so reported,[5] but it appears doubtful if much importance can be attached to these earlier results as we have since observed that carotin under certain conditions is a very labile compound. We do not desire to mislead our readers by indicating that we have conclusive evidence one way or another.

Provisionally, we are assuming that the fat-soluble vitamine is one of the yellow plant pigments, but we are not unmindful of the possibility that the reasons for the association of these properties in nature, viz., yellow pigmentation and this growth-promoting property may be a genetic one in some cases, while in others it may be indicative of mere similarity in physical if not chemical properties. If it is not a pigment, no doubt, instances will soon be found where it is found to occur liberally in non-pigmented materials. We already have indications that certain materials are as rich in the fat-soluble vitamine as is yellow corn, yet they are far less pigmented. Whether this can be explained in difference of kind of pigment which in yellow corn is known to be principally xanthophyll or whether we are dealing in these instances with the leuco compound remains to be seen.

It is scarcely necessary to elaborate on these findings or to point out their possible economic significance. Many investigations based on the general premises which we have here outlined are now in progress and will be reported as the evidence obtained seems to warrant a detailed discussion.

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[3] H. Steenbock, P. W. Boutwell and Hazel E. Kent, *Jour. Biol. Chem.*, 35, 517, 1918.

[4] L. S. Palmer and C. H. Eckles, *Jour. Biol. Chem.*, 17, 211, 223, 237, 245, 1914.

[5] H. Steenbock, P. W. Boutwell and Hazel E. Kent, *Proc. Amer. Soc. Biol. Chem.*, 1919.

## THE AMERICAN MATHEMATICAL SOCIETY

THE twenty-sixth summer meeting of the society was held at the University of Michigan, September 2–4, in conjunction with meetings of the Mathematical Association of America and the

American Astronomical Society. On Thursday afternoon there was a joint session, at which the following papers were presented:

"Mathematics and statistics," retiring address of the president of the Mathematical Association of America, by E. V. HUNTINGTON.

"The work of the National Research Council with reference to mathematics and astronomy," by E. W. BROWN.

Reports on the international conference of scientists at Brussels, by FRANK SCHLESINGER and L. A. BAUER.

The following papers were presented to the society:

*On wind corrections:* PETER FIELD.

*Cauchy's memoir of 1814 on definite integrals:* H. J. ETTLINGER.

*Expansion of any determinant in minors from rectangular panels:* L. H. RICE.

*Pseudo-canonical forms and invariants of systems of partial differential equations:* A. L. NELSON.

*On the separation of complex roots of an algebraic equation:* A. J. KEMPNER.

*Some theorems on the zeros of solutions of homogeneous linear differential equations of the nth order:* C. N. REYNOLDS, JR.

*Some theorems on the zeros of solutions of self-adjoint homogeneous linear differential equations of the fifth order:* C. N. REYNOLDS, JR.

*Proof of the existence of distinct three-dimensional manifolds with the same group:* J. W. ALEXANDER.

*Certain determinants expressible as circulants or skew-circulants:* E. D. ROE, JR.

*A brief account of the life and work of the late Professor Ulisse Dini:* W. B. FORD.

*The resolvents of König and other types of symmetric functions:* S. P. SHUGERT.

*Form of the number of subgroups of prime-power groups:* G. A. MILLER.

*A generalization of a formula of Schubert in enumerative geometry:* E. S. ALLEN.

*Joint axis congruences with indeterminate developables:* E. P. LANE.

*A modification of an integral test for the convergence and divergence of infinite series:* R. W. BRINK.

*Certain types of involutorial space transformations* (second paper): F. R. SHARPE and VIRGIL SNYDER.

*Transformations of surfaces applicable to a quadric:* L. P. EISENHART.

*Transformations of cyclic systems of circles:* L. P. EISENHART.

*Differential equations containing arbitrary functions:* G. A. BLISS.

*Functions of lines in ballistics:* G. A. BLISS.

*On the relative positions of the complex roots of an algebraic equation with real coefficients and those of its derived equation:* D. R. CURTISS.

*Urn schemata as a basis for the development of the theory of correlation:* H. L. RIETZ.

*Projective transformations in function space* (second paper): L. L. DINES.

*On the invariants belonging to a hypernumber in an algebra of infinite order:* J. B. SHAW.

*Conditions necessary and sufficient for the existence of a Stieltjes integral:* R. D. CARMICHAEL.

*Note on convergence tests for series and on Stieltjes integration by parts:* R. D. CARMICHAEL.

*Note on a physical interpretation of Stieltjes integrals:* R. D. CARMICHAEL.

*An apparent anomaly in errors of interpolated values:* H. A. HOWE.

*Transformations of a Stieltjes integral potential:* G. C. EVANS.

*Note on sequences of Stieltjes integrals:* T. H. HILDEBRANDT.

*Differential equations of motion of a projectile regarded as a particle:* W. H. ROEVER.

*Certain properties of binomial coefficients:* W. D. CAIRNS.

*On the shape of polynomial curves:* A. J. KEMPNER.

Abstracts of these papers and a fuller report of the meeting will be published in the November number of the *Bulletin of the American Mathematical Society.*

E. J. MOULTON,
*Acting Secretary*

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